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Vascular Training and Endovascular Practice in Europe

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Abstract *Objective:* To evaluate the influence of the status of vascular surgery (VS) training paradigms on the actual practice of endovascular therapy among the European countries.
Methods: An email-based survey concerning vascular surgery training models and endovascular practices of different clinical specialties was distributed to a VS educator within 14 European countries. European Vascular and Endovascular Monitor (EVEM) data also were processed to correlate endovascular practice with training models.
Results: Fourteen questionnaires were gathered. Vascular training in Europe appears in 3 models: 1. Mono-specialty (independence): 7 countries, 2. Subspecialty: 5 countries, 3. An existing specialty within general surgery: 2 countries. Independent compared to non-independent certification shortens overall training length (5.9 vs 7.9 years, $p = 0.006$), while increasing overall training devoted specifically to VS (3.9 vs 2.7 years, $p = 0.008$). Among countries with independent certification an average of 76% of aortic and 50% of peripheral endovascular procedures are performed by vascular surgeons, while the corresponding values, for countries with a non-independent certification, are 69% and 36% respectively. Countries with independent vascular certification, despite their lower average endovascular index (procedures per 100,000 population), reported a higher growth rate of aortic endovascular procedures (VS independent 132% vs VS non-independent 87%), within a four-year period (2003–2007). Peripheral endovascular procedures, though, have similar growth rates in both country groups (VS independent 62% vs VS non-independent 60%).
Conclusions: In European countries with VS as an independent specialty, vascular surgeons have a shorter total training period but spend more time in VS training, although they may not undertake a greater proportion of the endovascular procedures their countries appear to have adopted endovascular technologies more rapidly compared to the ones with non-independent VS curricula. Whether such differences influence patient outcomes requires investigation in future studies.

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Introduction/objective

Currently the European Union (EU) includes 27 member states, consisting of mixed cultures and profoundly variable health care systems, especially regarding the countries admitted recently. Vascular surgery (VS), currently awarded a section status among the UNION EUROPÉENNE DES MÉDECINS SPÉCIALISTES (UEMS), in terms of training, certification and practice is even more variable among European countries.[1–4] This is due not only to the diversity of the health systems. The rapidly changing face of the vascular discipline emerging, mainly from the endovascular revolution, plays an important role.

Vascular surgery is the clinical and scientific discipline concerned with the diagnosis, treatment and prevention of diseases affecting arteries, veins and lymphatics.[5] By definition, endovascular surgery, as a minimally invasive procedure to treat a vascular disease from inside of a vessel via a remote site, is a special ''area of interest'' within the wide field of vascular surgery.

In many European countries the endovascular specialist is not necessarily the vascular surgeon; it may be the radiologist and/or the cardiologist. Endovascular procedures are performed by each specialty in variable rates, collaborating or not, according to national laws and health systems.

In order to harmonize the vascular discipline across Europe, vascular training, certification and practice are currently being re-evaluated and reformed to meet the modern specialty and public demands.

The purpose of this study was to evaluate the influence of the status of VS and thus of the training paradigm on the actual practice of endovascular therapies among the European countries.

Methods

An email-based survey was distributed to a vascular surgery educator within 14 European countries (13 EU countries and Switzerland), in which an adequate contact could be identified. These contacts comprise national representatives of the UEMS Section and Board of Vascular Surgery elected by their medical unions or national societies. Many of these are heads of departments or national societies, either directly involved with Vascular Training in their countries or closely associated with the subject.

The questionnaire concerned the current structure of VS training (independence or not from general surgery, years of training, endovascular education, simulators, etc.) and certification, while also the current respondent-estimated percentage of endovascular practice among specialties (vascular surgeons, interventional radiologists and cardiologists). (Fig. 1) Fourteen completed questionnaires were returned.

European Vascular and Endovascular Monitor (EVEM) data,[6,7] of the 14 studied countries, also were processed to correlate endovascular practice in Europe with training models. EVEM, data are estimates of the total number of procedures based on three main data sources: (i) The annual Vascular News Registry questionnaire, (ii) Quarterly data from EVEM panel members (250 European Centres), (iii) National and European vascular and endovascular registries and industry crosschecks. By comparison with national audit (where it exists), a tendency of overstating the number of procedures has been found. A correction factor has been applied and the numbers finally announced by EVEM are the closest possible to actual national vascular and endovascular activity.

EVEM data were adjusted to country population estimates (procedures per 100,000 population − weighted), producing a procedural Index which we propose should be called either Open or Endovascular. This procedural index was calculated for aortic aneurysm procedures (abdominal and thoracic) and for peripheral procedures (aortoiliac, femoro-popliteal/tibial and carotid).

Data were tested for normality with the Shapiro−Wilk test. Comparisons between groups were made using *t*-test or paired samples *t*-test for normally distributed variables and Mann−Whitney test for the ones without normal distribution. Statistical significance was assessed with $p < 0$ .05.

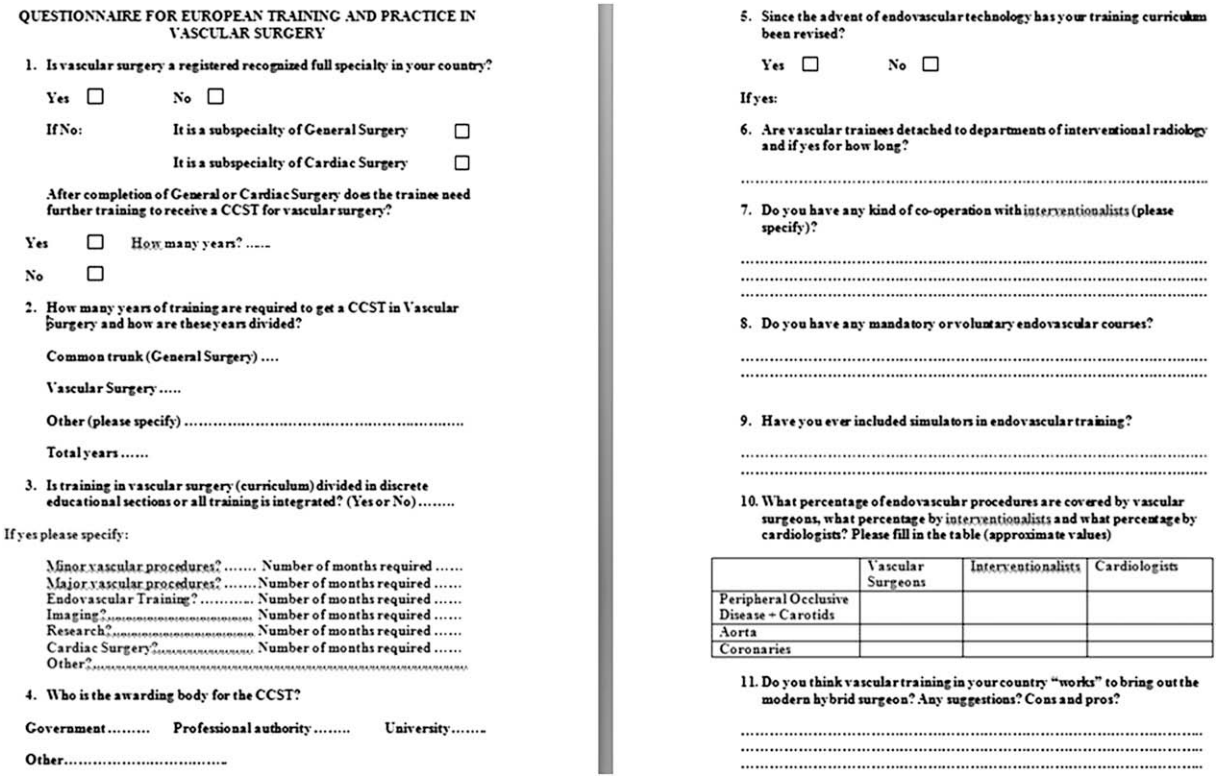
Results

Training models and certification

The existing training models and trainees' certification vary across the 14 surveyed countries and are summarized in Table 1. The specialty status of vascular surgery in Europe stands on 3 pylons. Of the 14 countries surveyed, VS is an independent specialty (mono-specialty) in 7, i.e., no prerequisite certification in general surgery (GS) or cardiothoracic surgery is required. In 5 countries, VS is a subspecialty of GS, meaning that VS certification is permitted only after prerequisite GS certification. Finally, in 2 countries VS is not an accredited surgical specialty and is included in GS certification. Total training years range between 5 in Italy and Spain up to 11 in UK.

In surveyed countries with independent certification, the minimum total length of training (general and vascular surgery) is a mean of 5.9 years (range 5−7) compared to a mean of 7.9 years (range 6−9) for countries with a non-independent certification, statistically significant ($p = 0.006$). The minimum mean duration of vascular surgery training in countries with independent certification (3.9 years, range 3−4.5) is significantly longer ($p = 0.008$) than in countries with subspecialty certification or no certification for vascular surgery (2.7 years, range 2−4). The minimum mean duration of general surgery is 1.9 (range 0.5−3) and 5.4 (range 2−8) years respectively ($p = 0.006$). The survey shows that independence shortens overall training length, while increasing overall training devoted specifically to vascular surgery (mainly to 4 years).

For most European countries endovascular training is integrated in the curriculum of vascular training, while in Austria, Germany and Spain it is provided through attachments in interventional radiology departments. In UK endovascular training is not mandatory for vascular trainees. Changes in the vascular curriculum to include endovascular skills are still pending; however a 2-year cooperative program between vascular surgery and interventional radiology is under way.



QUESTIONNAIRE FOR EUROPEAN TRAINING AND PRACTICE IN VASCULAR SURGERY

1. Is vascular surgery a registered recognized full specialty in your country?

Yes ☐ No ☐

If No: It is a subspecialty of General Surgery ☐

It is a subspecialty of Cardiac Surgery ☐

After completion of General or Cardiac Surgery does the trainee need further training to receive a CCST for vascular surgery?

Yes ☐ How many years? .....

No ☐

2. How many years of training are required to get a CCST in Vascular Surgery and how are these years divided?

Common trunk (General Surgery) ....

Vascular Surgery .....

Other (please specify) .....

Total years .....

3. Is training in vascular surgery (curriculum) divided in discrete educational sections or all training is integrated? (Yes or No).....

If yes please specify:

Minor vascular procedures? ..... Number of months required .....
Major vascular procedures? ..... Number of months required .....
Endovascular Training? ..... Number of months required .....
Imaging? ..... Number of months required .....
Research? ..... Number of months required .....
Cardiac Surgery? ..... Number of months required .....
Other? .....

4. Who is the awarding body for the CCST?

Government..... Professional authority..... University.....

Other.....

5. Since the advent of endovascular technology has your training curriculum been revised?

Yes ☐ No ☐

If yes:

6. Are vascular trainees detached to departments of interventional radiology and if yes for how long?

.....

7. Do you have any kind of co-operation with interventionalists (please specify)?

.....
.....
.....

8. Do you have any mandatory or voluntary endovascular courses?

.....
.....

9. Have you ever included simulators in endovascular training?

.....
.....

10. What percentage of endovascular procedures are covered by vascular surgeons, what percentage by interventionalists and what percentage by cardiologists? Please fill in the table (approximate values)

	Vascular Surgeons	Interventionalists	Cardiologists
Peripheral Occlusive Disease + Carotids			
Aorta			
Coronaries			

11. Do you think vascular training in your country "works" to bring out the modern hybrid surgeon? Any suggestions? Cons and pros?

.....
.....
.....

Figure 1 The e-mail distributed questionnaire.

Table 1 The status of vascular surgery training models and certification bodies in European countries

	Specialty	Years of training			Endo-education	Simulators and courses	Certification
		GS	VS	Total			
Austria	S	6	3	9	6 m IR	Yes	National assoc.
Belgium	N[a]	6	2[b]	8	—	No	Vascular society
Finland	M	3	3	6	Integrated	Yes	University
France	M	2—3	4	6—7	Integrated	Yes	Vascular society
Germany	M	2—3	4	6—7	Integrated and 1y IR[b]	Yes	Vascular society
Greece	M	3	4	7	Integrated	No	Government
Italy	M	0.5	45	5	Integrated	No	University
Netherlands	S	6	2	8	Integrated	Yes	Vascular society
Norway	S	4—5	3	7—8	Integrated	Yes	National assoc.
Portugal	M	2	4	6	Integrated	Yes	National assoc.
Spain	M	1	4	5	Integrated and 2 m IR[b]	Yes	Government
Sweden	S	2	4—5	6—7	Integrated	No	Government
Switzerland	S	6	3	9	Integrated	Yes	Vascular society
UK	N	8—11	2	8—11	Integrated[c]	No	National assoc.

M: mono-specialty (Independent) = No prerequisite certification in General Surgery is required.
S: Subspecialty = Vascular Surgery certification is permitted only after prerequisite General Surgery certification.
N: No Specialty = Vascular Surgery is not an accredited surgical specialty. It might be included in General Surgery or Cardiothoracic Surgery (or both) certification.
GS: General Surgery, VS: Vascular Surgery, lR: Interventional Radiology.
[a] VS training is incorporated in GS residency.
[b] Provisional.
[c] Under Revision: 2-year co-operative program between vascular and interventional trainees.

Simulators and endovascular courses are gradually incorporated in the core curriculum of vascular surgery in 9 out of 14 surveyed countries.

Formal certification of trainees' most frequently is performed by the national vascular societies ($n = 5$), followed by the national medical associations ($n = 4$) and government ($n = 3$) while university certification is less common ($n = 2$).

Endovascular practice

Among the 14 surveyed countries aortic endovascular procedures are mainly performed by vascular surgeons (in average 73%) with the exception of UK where interventional radiologists together with vascular surgeons handle the main workload of endovascular aneurysm repair. In Germany and Italy, 20% of cases are handled by cardiologists, (Table 2).

Peripheral endovascular procedures are generally performed by interventional radiologists (on average 54%). However, in Belgium, France, Portugal and Spain vascular surgeons undertake the vast majority of peripheral interventions, while in Germany and Italy cardiologists intervene at a considerable rate, (Table 2)

Relation of training to endovascular practice

Among countries with independent certification an average of 76% of aortic and 50% of peripheral endovascular procedures are performed by vascular surgeons, while the corresponding values, for countries with a non-independent certification, are 69% and 36% respectively. These numbers indicate a trend (though not statistically significant, $p = 0.59$ and $p = 0.48$ respectively) for increased rates of aortic and peripheral endovascular procedures by vascular surgeons who practice in countries with an independent vascular training model. (Fig. 2a,b)

Correlation of EVEM data population-adjusted comparisons, between years 2003 and 2007, and the vascular training model reported similar findings to those above. Countries with independent vascular certification, despite their lower average endovascular (aortic and peripheral) indexes showed a substantially higher 4-year growth rate of aortic endovascular procedures (VS independent 2.45 in 2003 and 5.68 in 2007; growth rate 132% vs VS non-independent 4.25 in 2003 vs 7.96 in 2007; growth rate 87%). Peripheral endovascular procedures, though, reported similar growth rates in both country groups (VS independent 36.4 in 2003 and 58.9 in 2007; growth rate 62% vs VS non-independent 57.3 in 2003 and 91.8 in 2007; growth rate 60%). A concomitant, approximately 30%, decline of open repair indexes for both groups of countries also is evident. Values and growth rates of endovascular and open indexes, within country groups, between years 2003 and 2007, are summarized in Table 3.

Table 2 The estimated status of endovascular practice in Europe

	Aortic endo procedures			Peripheral endo procedures		
	VS (%)	IR (%)	CARD (%)	VS (%)	IR (%)	CARD (%)
Austria	50	50	—	10	90	—
Belgium	90	10	—	90	10	—
Finland	50	50	—	5	95	
France	100	—	—	100	—	—
Germany	75	5	20	5	75	20
Greece	90	10	—	20	75	5
Italy	40	40	20	40	40	20
Netherlands	80	20	—	30	70	—
Norway	90	10	—	10	90	—
Portugal	90	10	—	90	10	—
Spain	90	10	—	90	10	—
Sweden	70	30	—	50	50	—
Swiss	90	10	—	50	50	—
UK	10	90	—	10	90	—

VS: vascular surgeons; IR: interventional radiologists; CARD: cardiologists.

Discussion

During the past 20 years there has been a clear international trend towards independent certification in vascular surgery. The need for an independent vascular certification arose from the evolution of vascular surgery into a distinct, well-defined specialty that deals with all aspects of vascular disease.

Independence of a specialty provides potential for increased flexibility in training, to optimize its residency training processes to meet the needs of the specialty and the patients it serves.[3]

Vascular surgery is a registered specialty in Europe since the foundation of the European Board of Vascular Surgery (initially incorporated in the European Board of Surgery) in 1996 and a recognized full specialty and a separate section of the UEMS, since 2004.[2] Regulations for the Certificate of Completion of Specialist Training (CCST) in vascular surgery vary across Europe. Vascular surgery was, for many years, a kind of subspecialty of either General Surgery or Cardiac Surgery depending on national or local legislation.[2,4] Our survey suggests that today vascular surgery as a mono-specialty is increasingly common (7 out of 14 surveyed countries), simultaneously shortening overall training length, while increasing training devoted specifically to vascular surgery. Endovascular techniques appear to be well integrated in vascular education and only a minority of countries send vascular residents to departments of interventional radiology for endovascular training.

Simulators and endovascular courses are gradually being incorporated into the core curriculum of vascular surgery. The educational value of courses incorporating endovascular simulators to enrich the training environment is no longer debated as several publications have confirmed its efficacy, validity, utility as a skills assessment tool and potential use in determining credential standards.[9–12] However, known shortcomings of simulator based curricula restrict widespread acceptance as the sole training and assessment tool.[13] Further technical

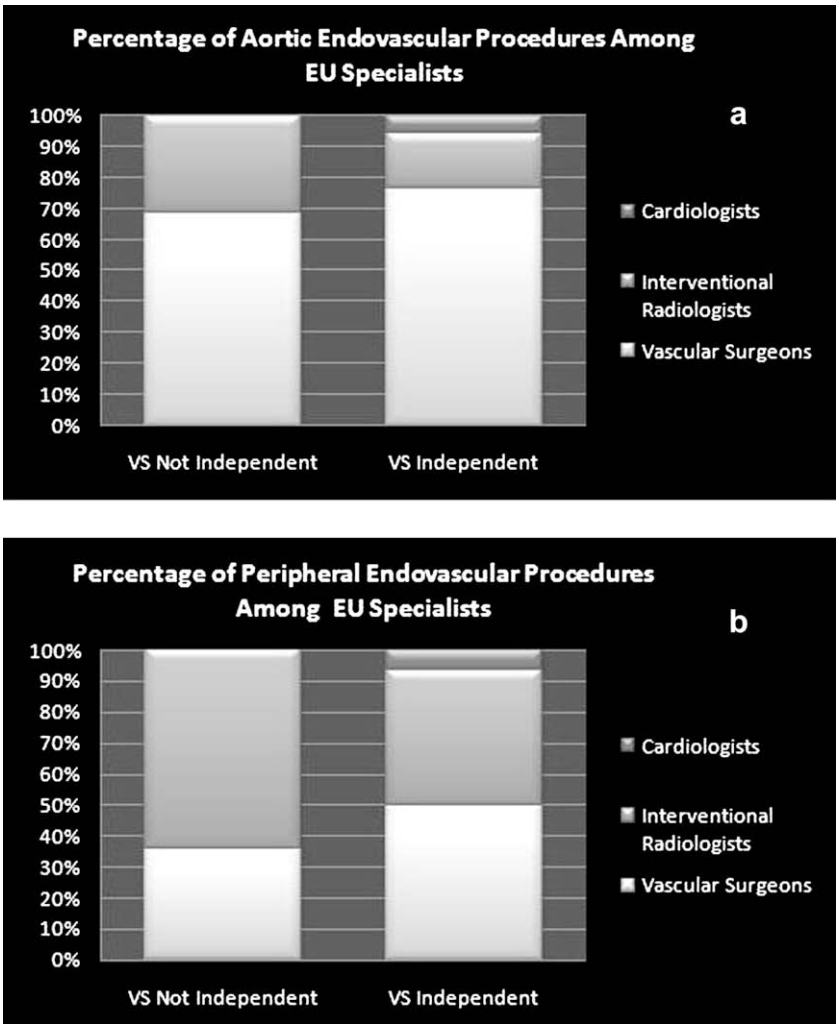


Figure 2 (a) Aortic endovascular procedures are mainly performed by vascular surgeons, irrespective of their country's vascular training model. However, these rates are even higher for vascular surgeons of countries with independent vascular certification. (b) Though peripheral endovascular procedures are mostly performed by interventional radiologists, the corresponding percentage for vascular surgeons who practice in countries with an independent vascular training model is higher compared to the vascular surgeons practicing in countries with non-independent training models.

advancements are required to develop and validate simulation-based training curricula so that they can reliably provide interventional skills.

While vascular training is re-evaluated to meet the current demands of endovascular expansion, vascular practice, in terms of endovascular sharing between specialties varies across the European countries. In our study, the estimated rates of specialist involvement in endovascular activities represent the main operator (vascular surgeon, radiologist or cardiologist). Increasingly, multidisciplinary working is evolving in many parts of Europe, although at different rates. However it is difficult to collect reliable data on what extent each discipline is involved in practice and training.

The model of vascular training may be responsive to current endovascular practice. Our survey showed that there is a trend towards increased rates of aortic and peripheral endovascular procedures being performed by vascular surgeons who practice in countries with an independent vascular training model. Moreover, correlation of population adjusted EVEM data to vascular training models showed a higher growth rate of the aortic endovascular index in countries with independent curricula, evidence for the faster incorporation of advanced endovascular technology.

The study has several limitations. The results on percentages of endovascular practice among specialties and EVEM data estimates may be biased. Our opinion is that, both estimated percentages, coming from UEMS representatives using data from their respective national societies, and EVEM data, coming from 250 European centres, report approximately the European reality. Until official pan-European inter-specialty registries become available, estimates and EVEM data will be useful tools (and currently the only existing ones) for monitoring vascular and endovascular activity in European countries. A final limitation of our study is that the number (14) of European Countries who responded is too small to identify any statistically significant differences between the training models.

Table 3 Average Open and Endovascular Indexes (procedures per 100,000 population) in 2003 and 2007, between 14 European Countries with independent (Finland, France, Germany, Greece, Italy, Portugal, Spain) and non-independent (Austria, Belgium, Netherlands, Norway, Sweden, Switzerland, UK) VS certification. ''Aortic'' indicates abdominal and thoracic aneurysm endovascular procedures and ''peripheral'' indicates aortoiliac, femoro-popliteal/tibial and carotid procedures

	VS independent ($n = 7$ countries) (mean ± SD)	VS Non-independent ($n = 7$ countries) (mean ± SD)	*p*-Value	95% Confidence interval	
Aortic endovascular index					
2003	2.45 ± 1.56	4.25 ± 1.76	0.067	−3.74	0.15
2007	5.68 ± 2.98	7.96 ± 2.23	0.068	−3.74	0.15
p-Value (2003 vs 2007)	0.013	0.002	—	—	—
% Growth	131.83	87.29	—	—	—
Peripheral endovascular index					
2003	36.37 ± 24.87	57.27 ± 19.21	0.104	−46.78	4.99
2007	58.85 ± 31.34	91.75 ± 27.78	0.060	−67.40	1.60
p-Value (2003 vs 2007)	0.001	0.001	—	—	—
% Growth[a]	61.80	60.20	—	—	—
Total endovascular index					
2003	38.83 ± 25.91	61.52 ± 20.20	0.093	−49.75	4.37
2007	64.53 ± 32.21	99.72 ± 29.28	0.054	−71.04	0.67
p-Value (2003 vs 2007)	0.001	<0.001	—	—	—
% Growth[a]	66.18	62.09	—	—	—
Aortic open index					
2003	14.31 ± 7.46	13.88 ± 3.91	0.895	−6.51	7.37
2007	10.70 ± 5.88	12.01 ± 4.33	0.643	−7.33	4.70
p-Value (2003 vs 2007)	0.002	0.026	—	—	—
% Growth[a]	−25.22	−13.47	—	—	—
Peripheral open index					
2003	46.17 ± 25.67	43.05 ± 17.20	0.794	−22.33	28.58
2007	32.04 ± 19.31	28.63 ± 13.45	0.707	−15.97	22.80
p-Value (2003 vs 2007)	0.002	<0.001	—	—	—
%Growth[a]	−30.60	−33.49	—	—	—
Total open index					
2003	60.49 ± 32.66	56.93 ± 19.90	0.810	−27.94	35.05
2007	42.75 ± 24.58	40.64 ± 16.64	0.854	−22.35	26.55
p-Value (2003 vs 2007)	0.002	<0.001	—	—	—
% Growth[a]	−29.32	−28.61	—	—	—

Data based on EVEM Panel Report and other BIBA research in Western Europe for 2003 and 2007. [6,7] Population data are 2007 estimates, available in www.internetworldstats.com/europe.htm [8]

[a] Growth has been calculated based on the differences between the indicated mean 2003 and 2007 indexes.

An important issue remains the lack of a formal program of training or accreditation in endovascular procedures.[14] The European Board of Vascular Surgery hopes to bridge the gap between the training systems, by establishing a pan-European examination: The Annual European Board assessments in Vascular Surgery (EBVS-exam since 2005, previously known as EBSQ-VASC).[15,16] The EBVS recommendations have been revised recently to include mandatory training in endovascular procedures. Endovascular interventions recently were included in the index procedures, with the desired number of 50 procedures required before a candidate can be admitted to the European examination. Endovascular skills assessment will be part of the examination by 2008, as the STRESS simulator was tested and evaluated during the 2007 examinations. Such a European examination could be used as an exit examination in the interests of standardization and harmonization of training. For the time being, the examination remains voluntary for most of the European nations.

In conclusion, in European countries with VS as an independent specialty, vascular surgeons have a shorter total training period, but spend more time in VS training. Although they may not undertake a greater proportion of the endovascular procedures, their countries appear to have adopted endovascular technologies more rapidly compared to the ones with non-independent VS curricula. Whether an independent specialty and its training model produces better patient outcomes requires investigation in future studies.

Conflict of Interest

R. Greenhalgh declares: Medical Director of BiBa Medical.

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